



The Impact of Swedish Forest Owners' Values and Objectives on Management Practices and Forest Policy Accomplishment

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Accepted: 16 December 2022 / Published online: 6 January 2023
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Abstract

Swedish forestry policy principles rest on voluntarism and a mutual interest among forest owners, the industry, and the state that timber production continuously be kept at a high level at the same time as environmental goals are achieved. An estimated 313,000 small-scale forest owners own half of Sweden's forestland, and thus their objectives and values, and how these impact their management behavior, are matters of national policy interest. From a survey targeting a random sample of small-scale Swedish forest owners ($n=652$), we found that overall forest owners found consumption objectives to be more important than production objectives. In line with this, they perceived social values, such as recreation, to be more important than economic values. Yet, on an aggregate level, timber production goals were fulfilled. Further, most forest owners left some of their productive forest untouched and applied restoration management, which could be interpreted as either intentional or unintentional considerations of the environmental goals. However, the environmental goals were not met on a national level. It can therefore be concluded that the voluntariness of the current forest policy seems to work when supported by the market's interest in and mechanism for timber production but fails when only "soft" instruments such as information campaigns, advisory services, and education are at hand to promote environmental goals. Additional economic incentives, such as payment schemes, might be required.

Keywords Survey · Forest policy · Forestry activities · Forest production · Environmental consideration

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Introduction

The transition from a fossil-based to a bio-based economy has increased the demand for wood for construction, fuel, and as an ingredient in various fossil-free chemical products. At the same time, the protection of nature for biodiversity reasons as well as for its social values is stressed, resulting in conflicting expectations regarding its use (Eriksson 2012; Sandström et al. 2011). To balance the different interests and conflicting demands involving forests, and to steer their management, forest policies can be developed and implemented by governments, institutions, organizations, or individuals. Similar to other policies, these are tools that guide the actions undertaken, and the intention with setting rules is that a certain outcome will be achieved (Grebner et al. 2013).

On a supranational level there are no formal forest policies, but there are strategies that affect the member states within the European Union (EU). For example, while the new EU forest strategy sets the guidelines for forestry within the union, each member state is responsible for its own forest policy. The strategy, rooted in the European Green Deal and the EU Biodiversity Strategy for 2030 (European Commission 2020), also states that forests will continue to play a crucial role for viable societies in the future, as a means of combating climate change and toward the achievement of a climate-neutral EU by 2050. In this way, the current governance problem in forest policy is no longer merely about the relationship between the public interest and the self-interest of the forest owners or users; a goal conflict exists in the public interest between biomass production and climate and environmental goals (cf. Appelstrand 2007).

There are substantial differences among the EU countries regarding the typical size of forest properties as well as the extent to which small-scale forest owners have the freedom to decide on management issues (UNECE/FAO 2019). In the EU, 43% of the land area is covered by forests and around 60% of the forest area is privately owned, of which the majority belongs to small-scale private individuals (Mauser 2021; Weiss et al. 2019). These owners constitute a heterogeneous group with varying objectives, values, and management behavior (Nordlund and Westin 2011; Weiss et al. 2019; Ficko et al. 2019). Therefore, the message conveyed in policies is not always interpreted by small-scale forest owners as the authorities intended, and forest owners have to adhere to a range of policies, among which forest policies are only one aspect (Lawrence and Dandy 2014; Feliciano et al. 2017).

A crucial dimension of governance and policy framework is the property rights system, by which the position of the owner in relation to the use of forest owned is defined through a set of norms, institutional decisions, and legally binding regulations (Appelstrand 2007; Cubbage et al. 2007). Consequently, prevailing property rights set the limits and scope for the individual forest owner's management decisions and thus what goods and services might be offered to the market as well as to society at large (Bourriad and Schmithüsen 2005). This in turn can be seen as a reflection of the cultural, historical, and political context of each country, and the difference among various European countries is thus significant (Nichiforel et al. 2018).

Objectives can be defined as “the end sought” and influence management behavior (Hugosson and Ingemarson 2004). The objectives of forest ownership are usually measured via the valuation of statements such as the importance of labor income and employment, berry and mushroom picking, place of residence, and protection of biodiversity. Forest owners have been found to have multiple objectives, and their management is a mix of social, economic, and ecological dimensions (e.g. Feliciano et al. 2017). As forest owners differ in their objectives for ownership—and are diverse in other respects as well—typologies have been used to segment them (Ficko et al. 2019). A typology is a “study of types, or a system of dividing things into types” (Cambridge Dictionary 2022). In a literature review of different typologies by Ní Dhubbáin et al. (2007), objectives were summarized into those whose primary goal was production (e.g., timber production, self-employment, and economic security) and those whose primary goal was consumption (e.g., recreation, aesthetics, and conservation). This categorization is similar to one in a recent study by Koskela and Karppinen (2021), who identified two dimensions: *economic security and income*; and *recreation, conservation, and aesthetics*.

Forest values concern the relationship between humans and the forest (environment), and are important for forest-related behavior (Eriksson 2012). Forest values have been categorized as emphasizing production or ecology, indicating anthropocentric values that focus on satisfying humans' needs and interests, or ecocentric values that stress the forest's inherent worth (McFarlane and Boxall 2003). The anthropocentric values have been further divided into economic and social values, the former being related to materialistic values such as income and the latter to non-material benefits such as recreation, wildlife, and scenery (Lidestav et al. 2020; Eriksson et al. 2012). However, forest owners' behaviors are commonly influenced by a mix of ecocentric and anthropocentric values, within their specific social-ecological environment. In this context, Tiebel et al. (2021, p. 840) identified key drivers for the expression of forest conservation perspectives. Based on a systematic literature review covering 22 European countries, they show that “female gender, higher levels of education, formalized forest management, an active relation to the forest, and ecological values of the property” have a strengthening effect on owners' conservation perspectives.

For forest owners, forest values are assumed to affect *management behavior*. In the case of forest management, this behavior consists of a “system of measures to protect, maintain, establish and tend forest; ensure provision of goods and services; protect forest against fire, pest and diseases; regulate forest production; check the use of forest resources; and monitor forests; as well as to plan, organize and carry out the above-mentioned measures” (UNECE/FAO 2019, p. 22). To varying degrees, the different management activities are carried out by the forest owner, sometimes supported by authorities, forest owner associations, contractors, and other service providers (UNECE/FAO 2019). Management behavior is influenced by policies and regulations, but also by the owner's values and objectives (Feliciano et al. 2017). In their study of management in seven European countries, Feliciano et al. (2017) found that sustainable management—managing their forest to preserve it for future generations—was important to owners, while they ranked economic-centered management the lowest.

The diversity and changes in the composition (sex, age, absent owners, degree of self-employment, knowledge, size of holding, values, etc.) of small-scale forest owners influence management practices (Gatto et al. 2019; Tiebel et al. 2021). The heterogeneity among owners has been regarded as an obstacle to reaching forest policy goals; however, this diversity can pave the way for different management approaches and provide a more diverse set of ecosystem services (Weiss and Živojinović 2021). Forest policies and national conditions (e.g., political, geographical, economic) also differ substantially among the EU countries, but can also change over time (Živojinović et al. 2015).

Focusing on Sweden, small-scale forest ownership has been a vital part of owners' livelihood as well as the national economy, for centuries (Sörlin 2019). Depending on political trends, the ongoing changes in the composition of forest owners, and the global market situation, the Swedish forest policy has transformed. Starting in the 1980s, a turn has taken place from a highly regulated forest policy to voluntariness, labelled "freedom under responsibility", meaning that the steering is typically done using "soft" instruments such as information campaigns, advisory services, and education (Appelstrand 2007, Wallin 2017, Wilkes-Allemann et al. 2021). The present forest policy also emphasizes the two goals of forest management—high and valuable timber production and preservation of environmental values—are equally important.

However, national inventories (SLU 2021; Swedish Forest Agency 2022) show that neither environmental goals (e.g., high proportion of broad leaf trees) nor production goals (e.g. regeneration and pre-commercial thinning) are meeting the quality requirements. This suggests that there are flaws in the forest owners' driving forces for what Appelstrand (2007, p 303–304) label "enlightened self-interest" framed by a "common understanding" of the purpose and meaning of the two goals. To understand the conditions and goals of the forest ownership among different types of forest owners is therefore crucial to the prospect of soft regulation (ibid). As demonstrated by Lodin and Brukas (2021), the actual practice may deviate from the silvicultural ideals because of external and unpredicted reasons, such as the experience of damages by storm or browsing.

Against this background, this paper sets out to analyze how the choice of management activities and the willingness to change these activities correspond to Sweden's national forest policy. The research questions are:

1. What management activities are applied, and how do they relate to ownership objectives and forest values?
2. What characterizes owners who are willing to change their management behavior?

Drawing on the Swedish situation, this article contributes to the understanding of if, and how, governance and forest policy through voluntarism can be efficient in achieving management goals in contexts where national and international guiding principles interact.

Contextualizing Small-Scale Forest Owners in Sweden

The “Swedish forestry model” is characterized by a “contract” between the state, the forest industry, and small-scale-forest owners, based on a mutual understanding of the importance of growing trees to deliver timber to the industry, but also that the revenue should be shared between the industry and owners. In this respect, forest owner associations, which currently organize half of Sweden’s small-scale-owned forestland (Kronholm 2015), are important players. Depending on the actual importance of a particular product, the state has established specific laws to enforce or promote the forest owners’ production and delivery of particular assortments. However, the overall role and interest of the state has been to maintain the forest resource. This has been done through a “systematic schooling and norm formation” of the forest owners using a combination of “sticks, carrots and sermons” (Törnqvist 1995). Which of the instruments has had the greatest weight and impact has varied over time. While the 1980s were characterized by extensive regulation and subsidies, the current forest policy, introduced in 1993, implies a minimum of regulations and no subsidies for commercial timber production purposes. The guiding principle is “freedom under responsibility”, meaning that the schooling and norm formation that have been going on for almost a century have had the desired effect. Thus, forest owners can now take greater, independent responsibility for their forest. In return for this increased freedom, the forest owner will partly take greater financial responsibility and partly take responsibility for acquiring the knowledge that increased environmental consideration requires.

No explicit quantification of the production targets exists in terms of harvest volumes. However, it is promoted by market mechanism, i.e., a well-developed industrial system that both demands and pays for timber and offers services for the harvesting and silvicultural operations. The harvested volumes have increased from 50 Million m³ in 1955 to 90 Million m³ in 2020 (SLU 2021), reflecting both increased forest growth and domestic industrial demand. In this context, the environmental goals that lack similar market mechanisms may be perceived as restricting or even counter to the economic interest of the forest owners without a similar market support (c.f. Appelstrand 2007). Yet, the forest owner must take everyday responsibility for natural and cultural environmental care in his or her forest management, according to Section 30 of the Swedish Forestry Act (1979). He or she is also expected to take voluntary responsibility for provisions not covered by the formal protection under the Environmental Code. In light of this, it is emphasized that voluntary efforts are a prerequisite for achieving the environmental goals. The latest follow-up of the environmental goals “Living forests”¹ (Swedish Environmental Protection Agency 2021 p. 316) shows that “measures taken to protect nature and the diversity

¹ To assess the fulfilment of the forest environmental goals the National environmental goal “Living forests” is applied, which is guided by the following 8 dimensions: Characteristics and processes of the forest land, Ecosystem services, Green infrastructure, Favorable conservation status and genetic variation, Endangered species and restored habitats, Foreign species and genotypes, Genetically modified organisms, Preserved natural and cultural environmental values, Outdoor life (Swedish Environmental Protection Agency 2021 p. 299: Authors translation).

of ecosystem services are not sufficient to stop the ongoing loss of habitats in the forest landscape” (authors translation).

According to the most recent official records for Sweden, in 2020 there were 313,084 individual private forest owners distributed across 221,852 management units covering 11,351 thousand hectares of productive forestland² (Swedish Forest Agency 2022). This area corresponds to 47% of all productive forestland in Sweden. When divided by management unit the average size is 51.2 hectares of productive forestland, while this figure is 36.8 hectares when divided by owner. Distributed by sex, 61% are men and 39% are women, and the mean age of both sexes is 61 years (ibid). The holding time is typically 20 years (Lidestav et al. 2017, pp. 117 and 132). Three-quarters (74%) of the management units are owned by someone living in the same municipality as the property, while the remaining are owned by non-residential individuals. For 67% of the productive forestland there are current forest management plans, and 46% of private individual land is also certified (Swedish Forest Agency 2022).

In terms of forest conditions and management practices, Forest Statistics 2020 (SLU 2021) reports a growing stock of 155 m³sk/ha on productive forestland owned by individual private forest owners, and a mean site productivity of 6.3 m³sk/ha/year, meaning that growing stock is 10% higher and site productivity is 15% higher than the average for all forest ownership categories in Sweden. This is partly explained by the fact that a higher proportion of the privately owned forest is located in southern Sweden, and partly by a higher proportion of older forest. Yet, about 60% of the harvested volume (52.2 M m³ out of 84.3 M m³) originated from small-scale forestland, which also means that about three quarters of the annual increment on productive forestland is logged (SLU 2021, Tables 3.11, 3.31, 4.6). However, there is also forestland where measures have been neglected. On 26% of the young stands, there is an immediate need for pre-commercial thinning (SLU 2021, Table 3.10). Regarding the quality of regeneration, 86% of the area in thicket stage is assessed as approved according to the Forestry Act, and the best results are found on the 83% that are treated with artificial regeneration methods, i.e., soil preparation and planting (Swedish Forest Agency 2022). Regarding planting and pre-commercial thinning, 26% and 42%, respectively, of the area is done by the owners themselves. Among the logging operations, small-scale forest owners are active in thinning (15% of the volume in cutting and 17% in off-road transportation), but not in final fellings. Overall, the forest operations carried out by the forest owners themselves correspond to 6345 annual people years, which can be compared to the 8762 annual people year for forest contractors reported in 2016 (ibid). Meanwhile, most forestry operations are carried out with the help of contractors and large-scale forest companies, which illustrates the interdependence between the forest industry and small-scale forest owners and clarifies the production-oriented practice among the latter.

² The Swedish Forestry Act states that forestry should only be carried out on forestland which, according to established criteria, can produce an average of one cubic meter of timber per hectare per year. In addition to this so-called productive forestland, there are some 2,604 thousand hectares of non-productive forestland owned by private individuals.

Methods and Data

Data Collection

This paper is based on the Swedish data from a questionnaire survey directed at small-scale, private forest owners in five European countries (see Juutinen et al. 2021). In Sweden, the survey was conducted as a postal survey from February through April, 2020, via the Swedish University of Agricultural Sciences (SLU). A random sample of 2000 small-scale forest owners with a minimum of five hectares of forestland was provided by the Swedish Forest Agency, the list contained the owners' names and addresses. A questionnaire, along with a letter of introduction and note of consent according to the General Data Protection Regulation (GDPR) was sent out in February. Some questionnaires could not be delivered as the owner had died, sold their property, or moved, which resulted in a net sample of 1920 forest owners. The questionnaire was to be completed by the respondent and returned in a postage-paid envelope along with the signed letter of consent. The research was conducted in accordance with the data protection legislation (GDPR).

In early March 2020, a reminder (including the questionnaire) was sent to non-respondents. The forest owners were given a unique ID in order to ensure that no reminders were sent to those who had already answered. Adhering to the GDPR, the link between the sample list and the data file was destroyed after the data collection was finished, ensuring that no respondents can be identified. Further, only respondents who submitted written consent to participate in the study were included.

In-house personnel registered data in Excel. Quality tests (double registration of 50 questionnaires) showed that <0.8% of the individual entries were errors. Some questionnaires had partial missing data, which was recorded as blanks. In some instances, the respondents had given multiple answers when only one was requested. Multiple answers were recorded as "99".

The total number of responses was 652, yielding a response rate of 34%. Women were underrepresented among the respondents (23% compared to the national average of 38%). Older respondents were overrepresented, with an average age of 68 years compared to the national average of 61. Respondents with large forest holdings were also overrepresented, with a mean of 92 hectares compared to the national average of 37 hectares (Swedish Forest Agency 2022). Although the sample was restricted to owners holding five hectares or more, 4.6% of the respondents reported that their holdings were smaller than five hectares. These cases were included in the analysis.

Questionnaire

The questionnaire (see supplement) contained questions about the forest owner him- or herself (age, sex, education, member of a forest owner association, etc.) and the forest holding (e.g., size, distance from home, whether certified or not). Further, the respondents were asked about their *objectives* for their forest ownership.

The objectives were measured using eight statements (see Fig. 1). The statements read “How important are item [hunting and fishing rights etc.]”. When assessing the importance of *forest values*, the respondents were asked how important economic, social and environmental forest values, respectively. Economic values were exemplified as income from timber, leasing hunting rights, and capital investment; environmental values involved preserving plants and animals, upholding good water quality, and carbon sequestration; and social forest values were described as, e.g., recreation, health, and cultural values. Both objectives and forest values were assessed on a seven-point Likert scale, ranging from 1 = not important at all, to 7 = very important. The respondents were presented 13 management activities (see Fig. 2), and asked to what extent—high, some, or no—they applied various management activities, and whether they intended to decrease, increase or not change the extent of applying of the management activities within the next five years.

Data Analysis

Group differences were tested using Chi square, setting the significance level at 0.05. Variables on Likert scales were analyzed using ANOVA. The variable *self-employment* was based on how many days a year the respondent worked with their forest holding, and was recoded to an ordinal scale: 1 = 1–7 days (26% of the observations), 2 = 8–20 days (32% of the observations), 3 = 21–40 days (19% of the observations), and 4 = 41 days or more (23% of the observations). Size of holding varied from 1 to 2000 hectares and was recoded into four categories: 1 = 1–16 hectares (23% of the observations), 2 = 17–41 hectares (26% of the observations), 3 = 42–94 hectares (26% of the observations), and 4 = 95 hectares or more (25% of the observations). A factor analysis, with varimax rotation, was performed to reduce the number of forest owner objectives. To estimate whether, and to what extent, different owner characteristics affected the probability of applying various management activities, logistic regression analysis was performed.

Results

Respondent Characteristics

The respondents had owned their forestland an average of 28 years, and a majority (78%) of the holdings had a residential building (Table 1). However, only 40% of the owners lived permanently on their holding. About half of the respondents were members of a forest owner association (FOA), two-thirds had a management plan for all or part of their forestland, and 40% had certified all or part of their forest. There were significant differences between men and women in how they had acquired their holding. Women had inherited their holding to a significantly greater extent – 53% of the women compared to 24% of the men – while men had bought their property to a greater extent ($p < 0.001$). Men had owned their property longer, lived closer to

Table 1 Respondent characteristics

Sex	Male	77%
	Female	23%
Age	Mean	65.1 years
	Median	66.0 years
Main occupation	Self-employed	23%
	Employed	28%
	Retired	49%
Education level	Junior high	40%
	High school	23%
	University	37%
How acquired	Heritage, gift	32%
	Bought within family	32%
	Bought on open market	21%
	Multiple answers	15%
Residential building	Yes	78%
Years of ownership	Mean	28 years
	Median	29 years
Distance to holding	Mean	58 km
	Median	1 km
Size of holding(s)	Mean	92 ha
	Median	42 ha
Days of work in forest	Mean	35 days
	Median	20 days
Member of FOA	Yes	54%
	No	45%
	Don't know	1%
Certified	Yes	38%
	No	54%
	Partly	2%
	Don't know	6%
Management plan	Yes	57%
	No	33%
	Partly	9%
	Don't know	1%

their holding, and had a larger holding than women did ($p < 0.05$). Further, men had certified their forest ($p < 0.01$) to a greater extent. However, there were no differences in FOA membership or having a management plan.

Forest Ownership Objectives and Forest Values

The forests yield a variety of uses for the owners, and the respondents' objectives for their forest ownership were many. Overall, having a place to live, the possibility for hunting, fishing, and recreation, and fuelwood for one's own consumption were considered to be the most important objectives, while revenues from farm tourism were perceived as the least important (Fig. 1).

A factor analysis reduced the objectives into two components (Eigenvalue 49.486). The first component was labelled *consumption* and included fuelwood for one's own consumption, the possibility to hunt and fish, non-wood products (such as berries, mushrooms, and wild meat), and place of residence. The second comprised production (economic) objectives: monetary income, revenues from farm tourism, capital assets, and revenues from nature protection. These components are in line with Ní Dhubbáin et al. (2007). On average, the consumption objectives were assessed to be significantly more important than the production objectives, at 4.08 (std. 1.68) compared to 2.80 (std. 1.18). The higher the degree of self-employment, the more important both consumption and production objectives were ($p < 0.01$). Forest owners who had a management plan, had their forest certified, and were members of an FOA assigned higher importance to production than their counterparts did ($p < 0.01$), and there was a significant correlation between size of forest holding and production objectives ($p < 0.000$). There were no significant differences in assessments between men and women.

When asked what was important about their forest ownership—i.e., their forest values—the respondents found social values (recreation, health, cultural values, etc.) to be more important than environmental (preserving plants and animals, good water quality, carbon storage) and economic (timber, leasing hunting rights, capital

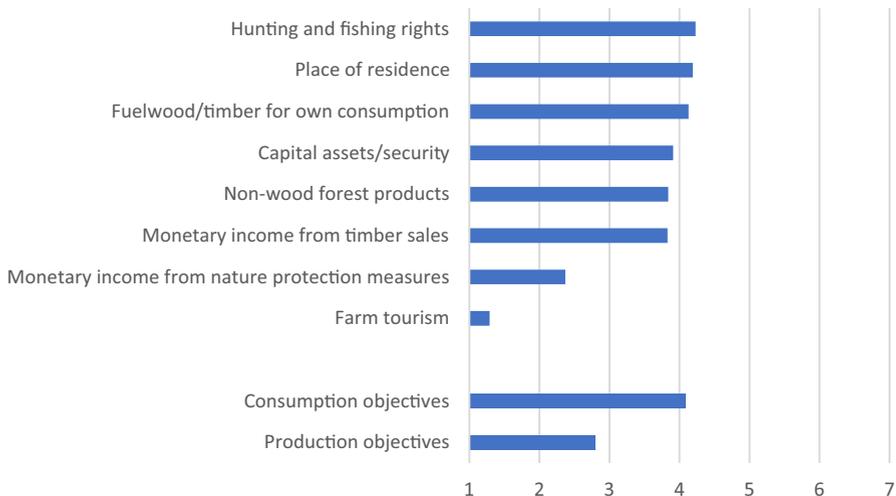


Fig. 1 Objectives for forest ownership; individual objectives and objectives reduced into components. Assessments were made on a seven-point scale from 1 = not important at all to 7 = Very important

assets) values (Table 2). There were some significant group differences in how values were assessed. Women perceived environmental values ($p < 0.001$) and social values ($p < 0.01$) to be more important than men did, while there was no significant difference in how economic values were assessed. Owners who had their holding certified, were members of an FOA, or had a management plan perceived economic values higher than their counterparts ($p < 0.001$), but for everyone, economic values were perceived to be less important than social and environmental values. Owners of holdings larger than 94 hectares stressed all forest values significantly higher than did those with holdings smaller than 42 hectares. The importance of all values increased with the degree of self-employment.

Table 2 Assessment of forest values (important for ownership) by owners with different characteristics

	Economic values	Environmental values	Social values
Total	4.11	4.77	5.37
<i>Sex</i>			
Male	4.15	4.61	5.14
Female	3.92	5.30	5.47
<i>Certified</i>			
Yes	4.65	4.88	5.15
No	3.78	4.65	5.53
<i>Member of FOA</i>			
Yes	4.39	4.86	5.25
No	3.73	4.62	5.48
<i>Management plan</i>			
Yes	4.63	4.85	5.26
No	3.41	4.67	5.18
<i>Size of holding/s</i>			
1 = 1–16 ha	2.98	4.65	5.15
2 = 17–41 ha	3.72	4.66	5.20
3 = 42–94 ha	4.56^a	4.86	5.29
4 = > 94 ha	5.02	4.87	5.28
<i>Self-employment</i>			
1 = 1–7 days/year	3.45^b	4.46	4.80^c
2 = 8–20 days/year	3.84	4.64	5.23^c
3 = 21–40 days/year	4.54^b	5.03	5.64^c
4 = > 40 days/year	4.91	5.08	5.40

Assessments were made on a seven-point Likert scale from 1 = not important at all to 7 = very important

Bold numbers indicate significant group differences $p < 0.05$

^aNo significant difference between Groups 3 and 4

^bNo significant difference between Groups 1 and 2, or Groups 3 and 4

^cNo significant difference between Groups 1 and 2, Groups 2 and 3, or Groups 3 and 4

Applied Management Activities

Most respondents were active to at least some extent when it came to managing their forest on their own. Half of them worked more than 20 days per year in or with their forest. About half of them reported that they had done regeneration themselves, 65% had done pre-commercial thinning, and 63% were active in planning. In addition to working with different activities themselves, many had contractors carrying out services. They bought thinning and harvesting services more often than carrying them out themselves, while the opposite was true for regeneration and planning.

Most activities were carried out to a high, or some, extent, either by the forest owners carrying them out themselves or hiring a company or organization to do the work (Fig. 2). Only two activities—reduced rotation period and fertilization—were rarely applied. About 40% of the respondents applied thinning and pre-commercial thinning to a high extent, and 50% to some extent. Further, artificial regeneration was applied to a high extent.

Forest ownership objectives and the assessment of the different forest values varied between those who applied a specific management activity and those who did not (Table 3). Respondents who applied more production-oriented activities—such as soil preparation, fertilization, artificial regeneration, maintaining and investing in forest roads, and reduced rotation period – had higher production objectives compared to those who did not ($p < 0.05$). Respondents who applied more nature-oriented activities (e.g., natural regeneration and extended rotation period) had higher consumption objectives than their counterparts did ($p < 0.005$). For some activities—thinning, more mixed and broad-leaved species, and restoration management—both production objectives and consumption objectives were higher among those who applied them compared to those who did not. Overall, though, consumption objectives were valued more highly than production objectives.

Regardless of management activity and regardless of whether or not they were applied, social forest values were perceived to be more important than environmental

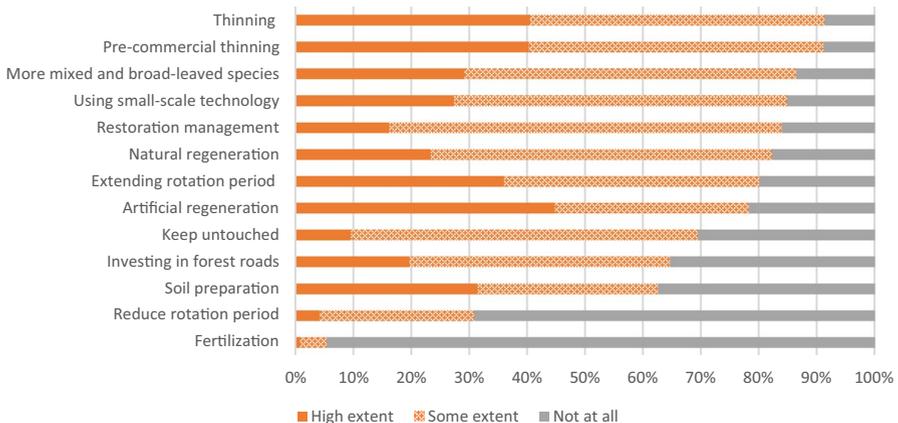


Fig. 2 Application (in percent) of various management activities to high extent, some extent or no extent

Table 3 Objectives and forest values (mean values) among those who applied various management activities to some extent or to a high extent

Management activity applied	Production objective	Consump. objective	Ec. values	Env. values	Social values
<i>Soil preparation</i>					
Yes	3.04	4.06	4.54	4.72	5.21
No	2.41	4.12	3.39	4.88	5.27
<i>Fertilization</i>					
Yes	3.75	4.30	5.33	4.91	4.97
No	2.76	4.06	4.03	4.77	5.23
<i>Artificial regeneration</i>					
Yes	2.96	4.09	4.40	4.75	5.21
No	2.25	4.07	3.06	4.92	5.29
<i>Natural regeneration</i>					
Yes	2.81	4.23	4.12	4.92	5.34
No	2.74	3.41	3.91	4.00	4.54
<i>Thinning</i>					
Yes	2.89	4.16	4.19	4.79	5.25
No	2.10	3.56	3.35	4.65	4.98
<i>Pre-commercial thinning</i>					
Yes	2.86	4.13	4.18	4.81	5.24
No	2.24	3.67	3.35	4.37	5.08
<i>More mixed and broad-leaved</i>					
Yes	2.87	4.20	4.19	4.87	5.30
No	2.40	3.34	3.48	4.10	4.67
<i>Reduced rotation period</i>					
Yes	3.13	3.98	4.50	4.54	5.01
No	2.64	4.10	3.89	4.88	5.31
<i>Extended rotation period</i>					
Yes	2.84	4.20	4.13	4.89	5.36
No	2.70	3.68	4.03	4.38	4.70
<i>Invest and maintain forest roads</i>					
Yes	3.03	4.09	4.48	4.79	5.21
No	2.39	4.06	3.40	4.76	5.24
<i>Leave untouched</i>					
Yes	2.88	4.26	4.12	5.08	5.44
No	2.64	3.69	4.07	4.08	4.69
<i>Small-scale technology</i>					
Yes	2.84	4.26	4.10	4.87	5.35
No	2.60	3.05	4.10	4.21	4.51
<i>Restoration</i>					
Yes	2.93	4.17	4.23	5.02	5.34
No	2.23	3.27	3.33	3.47	4.40

Bold numbers indicate significant difference $p < 0.05$

and economic forest ones, and in most cases environmental values were assessed to be more important than economic ones. The economic forest values were significantly higher among those who applied activities in line with the Swedish forest policy's timber production goal—soil preparation, artificial regeneration, fertilization, reduced rotation period, pre-commercial thinning, and thinning—but also more broad-leaved species and restoration management, compared to those who did not. Social and environmental forest values were higher among those who applied activities in line with the forest policy's aim of promoting environmental consideration: natural regeneration, more mixed and broad-leaved species, extended rotation period, leaving forests untouched, using small-scale technology, and restoration.

The logistic regression model showed which owner attributes or characteristics affect the probability of applying the various management activities, with results revealing a somewhat scattered picture (Table 4). For example, age was significant in explaining the propensity to apply soil preparation, pre-commercial thinning, and extended rotation period, but was not significant for regeneration. Being a member of an FOA was significant in explaining the probability of applying artificial regeneration and soil preparation ($p < 0.05$). A higher degree of self-employment (working actively in the forest) was significant in explaining the application of thinning, more mixed and broad-leaved species, reduced rotation period, and investing in forest roads ($p < 0.05$). Higher valuation of consumption objectives increased the propensity to apply the more nature-oriented activities of natural regeneration, extended rotation period, and use of small-scale technology. Finally, production objectives and social values were not significant in any model. The tested variables could only to a low degree (Nagelkerke $R^2 < 0.2$) explain the application of the activities natural regeneration, extended rotation period, leaving the forest untouched, and use of small-scale technology. Soil preparation and artificial regeneration had higher explained variance in the models, but the significant attributes were not identical.

Intention to Increase Application of Management Activities

Although there was limited interest among the respondents in changing their application of various management activities, about a fifth of them intended to increase pre-commercial thinning, the use of mixed and broad-leaved species, and thinning within the next five years (Fig. 3). The intention to decrease the application of activities was very low, ranging from 7.8% for extended rotation period to 0.5% for decreasing the use of more mixed and broad-leaved species. There were few differences in characteristics between those who intended to increase an activity on one hand and those who indicated no change or a decrease on the other hand. Respondents who indicated an intention to increase the use of more mixed and broad-leaved species were to a higher degree member of an FOA, had a forest management plan and had their forest certified compared to those who indicated no change or a decrease ($p < 0.05$). Those who intended to increase soil preparation and those who intended to increase the application of reduced rotation period had higher economic forest values than their counterparts did ($p < 0.05$). Respondents who had the intention to increase fertilization were younger, had their forest certified, had larger

Table 4 Attributes affecting probability of applying various management activities

Activity (<i>Nagelkerke</i>)	Sex	Age	FOA	Self-activ.	Plan	Cert.	Objective	Cons.	Econ.	Env.	Soc.
Soil prep. (0.371)	Male**	Older*	Yes**				Larger***				Low*
Fertilization (0.212)							Larger*				
Artif. regen. (0.366)			Yes*			Yes*	Larger*		High***		
Natural regen. (0.152)											
Thinning (0.322)				More**							
Pre-comm. thin. (0.246)		Older*	Yes*								
Mixed (0.270)				More**							High*
Red rot. period (0.190)				More**	Yes**						
Ext rot. period (0.116)		Older*							High*		
Forest roads (0.392)			Yes*	More*		Yes*	Larger**			Low*	High**
Untouched (0.157)											
Small-sc. techn. (0.175)	Male*								High***		High***
Restoration (0.288)											High***

*p<0.05, **p<0.01, ***p<0.001

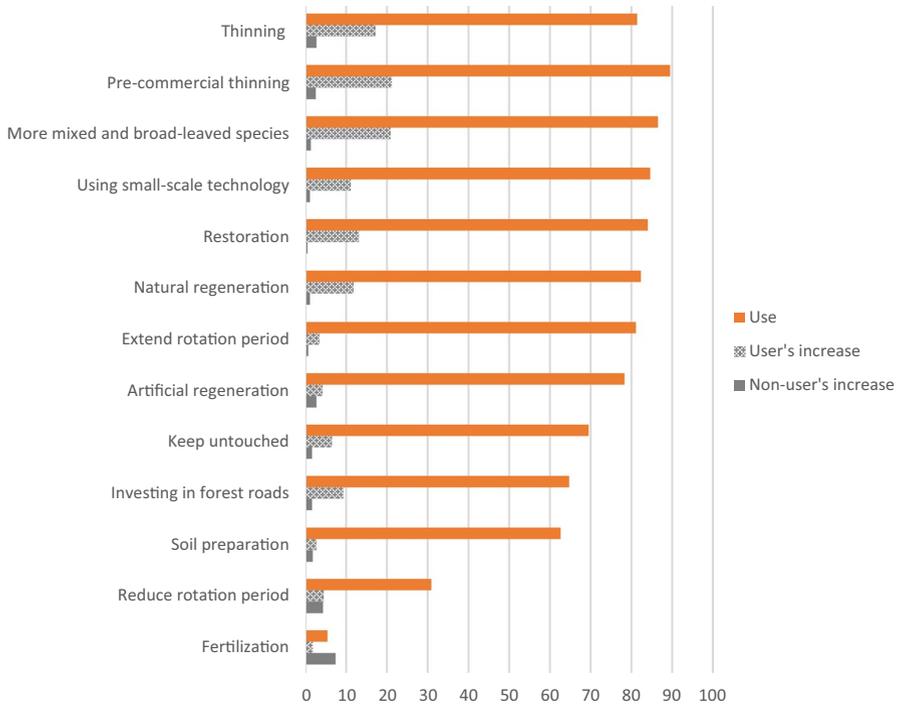


Fig. 3 Percentage of respondents who applied (to some degree or to a high degree) various management activities, and their willingness to increase application, and willingness of present non-users to apply (increase) activity

holdings and higher economic forest values than their counterparts ($p < 0.05$). Forest owners who would increase restoration held higher environmental values than their counterparts did ($p < 0.05$).

Discussion

Our results suggest that most forest owners have multiple objectives with respect to their forest ownership (Research Question 1), which is in line with Feliciano et al. (2017). Similar to previous studies (e.g., Lidestav and Nordfjell 2005, Umaerus et al. 2019), consumption objectives (e.g., fuelwood and timber for one's own consumption, having a place to live, and hunting) were rated as more important than production objectives (e.g., revenue from timber sales, capital assets). However, production and consumption objectives should not be considered as conflicting, but rather complementary. One apparent argument is that many Swedish forest owners invest their time in forest management work, and the outcome of this self-activity may be both a pile of timber for sale and a stack of fuelwood for private use (Westin et al. 2017). Similar attitudes and behavior among forest owners in Finland has also been

reported by Matilainen et al. (2017). Another argument is that forest properties are generally large enough and have sufficiently varying conditions for both timber production and other social activities. Further, a majority of forest estates are built-up properties (Lidestav et al. 2017, pp. 118–119), serving either as a permanent place of residence (34% of the respondents in this study lived on their property) or a second home, and are thus capital assets.

Forest owners who apply production-oriented management activities (e.g., soil preparation, artificial regeneration) have higher economic forest values compared to those who do not apply these activities. Owners who engage in nature-oriented management (i.e., more mixed and broad-leaved species, restoration, and leaving forest untouched) have higher environmental and social values compared to those who do not (Table 3). However, regardless of the management activity, social values are considered the most important throughout. This suggests that high social and environmental values do not exclude production-oriented activities, at least on parts of a property. As shown in Table 4, the probability of applying different production-oriented activities is more likely to be affected by the characteristics of the owner and the holding rather than by objectives and values. For example, the larger the holding, and with FOA membership, the more likely it is that production-oriented activities are carried out. This pattern has been reported in a number of previous studies (see e.g., Eggers et al. 2014; Lidestav and Arvidsson 2012). According to Eggers et al. (2014), property size is the most important factor in the choice of management strategy, and the size in turn is related to economic importance, interest, and knowledge about forestry issues. Environmental forest values, on the other hand, positively affected restoration, leaving forests untouched and applying more mixed and broad-leaved species. This result is in line with studies that show that values affect management behavior (e.g., Eriksson and Fries 2020). Based on our analysis, we argue that the methods and tools for management planning (e.g., forest management plan and certification schemes) and forestry operations (e.g., mechanized harvesting) are typically standardized, production-oriented, and influenced by the economy of scale adapted to the logistic and production systems of the large-scale forestry. The rather extensive self-activity also reported in this study is mainly connected to activities that reduce the costs of measures that are compulsory (e.g., regeneration) or are regarded as long-term investments (e.g., pre-commercial thinning). For these activities there is also a substantial supply of small-scale technology (Lindroos et al. 2005), which is applied by 85% of the respondents in this study. However, the use of small-scale technology is more associated with consumption objectives (Table 3), among which fuelwood for one's own use is likely the main activity. The share of fuelwood is assessed to be 7–10% of the total felling in Sweden (Swedish Forest Agency 2022), and it can be assumed that this takes place mostly on small-scale, private properties.

Still, it remains to be scrutinized to what extent small-scale forest owners are satisfied (or not) with the management outcomes with regard to their forest values and objectives. The observed weak association between management behavior and forest values and objectives could be due to a lack of service provision by authorities and the market, e.g., with regard to alternative methods, meaning that many forest owners have to settle with the next best practice. Further, forest

owners who are unable to carry out measures themselves in accordance with their objectives, and cannot find the desired service on the market, may choose to do nothing at all. Our finding that few owners are planning to change their management behavior (RQ2), suggests that it is more likely to expect an increase among those already performing an activity, and that there is an initial threshold that poses a particular challenge for a forest policy based on soft regulations.

This paper set out to analyze how one's choice of management activities and willingness to change these activities correspond to the Swedish national forest policy, with the overall aim to assign equal importance to timber production and environmental considerations. Our results indicate that the small-scale forest owners, on an aggregate level, contributes to the fulfilment of the forest policy's production goals as they apply soil preparation, regeneration, pre-commercial thinning, and thinning to a high degree. This in turn is a precondition for a durable rotation forestry practice that is the dominant management system in Sweden to a high degree. Furthermore, a comprehensive analysis of the forest conditions, problems, and potential measures for forest production by Bergquist et al. (2016), concludes a further increase of forest production within the framework of sustainable forestry is desirable, indicates that the production goals are not yet fulfilled. At the same time, it is emphasized that the current regulations provide significant scope for forest owners to manage their forest with different goals. Whether this should be understood as a goal in itself, or a prerequisite for goal fulfillment, is unclear. Regardless of which, it appears as "the systematic schooling and norm formation" observed by Törnqvist (1995), and the silvicultural ideals described by Lodin and Brukas (2021) impacts the behavior of small-scale forest owners in line with the forest policy production goals. However, when it comes to environmental considerations the situation is less favorable. Our survey shows that a majority of the respondents leave some of their productive forest untouched and apply restoration management, indicating that they consider the environmental objectives. Still, almost a third of them report that they do not leave any productive forestland untouched, which may not comply with the environmental considerations expressed in the current forest policy. A major issue in this regard seems to be the lack of a common understanding of the environmental goals as such, and consequently differing views concerning the extent to which the environmental considerations are met, as well as the need for further action (Swedish Forest Agency 2011, 2015). In this regard, the forest policy, including the environmental goal of 'Living forests', expects forest owners to show more comprehensive ambitions than requested by the Forest Act, in preserving the natural and cultural environmental values (Swedish Forest Agency 2015). Thus, while many of the respondents in our study report environmental considerations in their management practice through the use of, mixed and broad-leaved species, restoration to a high degree and other activities, the most recent evaluation by the Swedish Environmental Protection Agency (2021) shows that the national sustainability goal of 'Living Forests' is not being met. Although this study is based on a survey among Swedish forest owners, authorities lack of clearly communicating how forest owners are to understand and implement management activities is most likely

not restricted to Sweden. To change management behavior may need a mix of both soft and hard instruments.

Conclusion

The guiding principle of the Swedish forest policy is freedom under responsibility, and this voluntariness seems to work when supported by the market's interest in and mechanism for timber production. It has, however, been insufficient to meet the environmental goals of the same policy. Apparently, the use of "soft" instruments such as information campaigns, advisory services, and education has not been enough to bring about a common understanding of the environmental goals and how they can be achieved. Additional incentives, such as payment schemes might be needed to motivate forest owners to engage in management that supports biodiversity. At the same time, as the composition of forest owners are changing, the environmental goals may become more important.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11842-022-09538-4>.

Acknowledgements The survey was constructed within the ValoFOR project Small Forests—Big Players: Valorising small-scale forestry for a biobased economy.

Funding Open access funding provided by Umea University. This study was supported by the Swedish Governmental Agency for Innovation Systems (Vinnova) as a part of the project ValoFor (Project no. 2018-04978) "Small Forests—Big Players: Valorising small-scale forestry for a bio-based economy (ValoFor)". The ValoFor is supported under the umbrella of ERA-NET Cofund ForestValue, which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement N° 773324.

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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